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Abstract withdrawn

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Monte Carlo simulation of the Elekta VersaHD linac

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Purpose or Objective: The Elekta VersaHD linac is characterized by the new 160 leaves Agility MLC and the ability to work in Flattening Filter Free (FFF) mode. The objective of this work was to create an accurate Monte Carlo (MC) model of this linac for 6MV and 6MV FFF beams.The Elekta VersaHD linac is characterized by the new 160 leaves Agility MLC and the ability to work in Flattening Filter Free (FFF) mode. The objective of this work was to create an accurate Monte Carlo (MC) model of this linac for 6MV and 6MV FFF beams.

Material and Methods: The BEAMnrc code was used to create detailed models of the linac head for the 6MV and 6MV FFF beams based on the manufacturer data supplied by Elekta. MC simulation with the BEAMnrc code generated the phase-space file using DBS and BCSE variance reduction techniques. This file was used in the DOSXYZnrc code to calculate PDDs, profiles and output factors in a water phantom at SSD= 90 cm. Results from the simulations were compared against measurements performed during commissioning of the linac using an PTW water phantom, a PTW SemiFlex ion chamber and a Scanditronix stereotactic diode. Field sizes from 1x1 cm to 20x20 cm were taken into consideration. The following parameters of the MLC and of the incident electron beam had to be determined to provide the best fit between the measured and calculated data: leaf bank rotation (LBROT) angle, leaf spacing at isocenter, the incident beam spectrum (mean energy and FWHM, under assumption of Gaussian distribution), width (FWHM) and angular divergence. The incident beam spectrum was defined by matching PDDs, the beam width was determined by matching the penumbra in in-plane and cross-plane directions. The angular spread was adjusted by matching the profiles of 20x20cm2 field. LBROT angle and leaf spacing were obtained by matching the interleaf measured and calculated values. Output factors (relative to a 10x10 cm2 field) were calculated under assumption of negligible backscatter from the MLC to the ion chamber.

Results: Calculated and measured PDDs for all field sizes agreed within 1%/1mm. Lateral profiles in both (in-plane and cross-plane) directions agreed within 2%/1mm for all field sizes. Output factors agreed with 3%. For the 6MV beam, the mean energy and FWHM of the incident electron beam were 6.5MeV and 0.5MeV respectively. For the beam width, FWHM in the in-plane direction was 0.15cm and in the cross-plane direction 0.25cm. For the 6MV FFF beam the mean energy and FWHM of the incident electron beam were 7.4MeV and 0.5MeV. FWHM in the in-plane direction was 0.10cm and in the cross-plane direction 0.20cm. The mean angular spread was 1.1 degree for both beams. LBROT angle was 0.01radian. The leaf spacing at isocenter was 0.5cm.

Conclusion: An accurate MC model for the Elekta VersaHD linac was created to be used with the BEAMnrc code. This model will be employed for our future work of the Agility MLC characterization and modeling of stereotactic cones.

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Optimisation of the initial parameters and efficiency in Monte Carlo simulation for Cyberknife

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Purpose or Objective: To optimize the initial parameters and calculation efficiency in Monte Carlo simulation for Cyberknife G3 system.

Material and Methods: BEAM09 Monte Carlo codes were used for this study. The BEAMnrc code was used to simulate the treatment head and generate the phase space files. The DOSXYZnrc code was used to calculate the depth dose curves(percentage depth dose, PDD), lateral profiles and the output factors. Mean incident electron energy and the radial intensity (FWHM) were used to determine of initial electron parameters. For the calculation of dose in the region of interest, the use of smaller voxel size may increase the calculation time; conversely, the adaption of larger voxel size may cause a higher partial volume effect. This study aims to investigate the optimal voxel size for dose calculation in a water phantom to achieve a reasonable simulation efficiency and an acceptable accuracy.The Kα method was used for the optimization by comparing the differences between diode measurement data and MC simulations in PDDs and profiles. Disagreement between simulation and measurement were evaluated through the dose differences of PDDs from depths of 1.5 to 20 cm, and the lateral profiles of 80% field width. The DTA (distance to agreement) at lateral positions of 20% to 80% dose profiles of penumbra region were also used for the comparisons.

Results: For the efficiency of dose calculation, by setting the voxel size equal to one tenth of field width would produce a optimal simulation efficiency and an acceptable accuracy. For the optimization of initial parameters, the optimal mean incident electron energy is 7.1 MeV and the FWHM(R) is 2.4 mm. According to these parameters, the dose differences of the PDDs is about 1% from depths of 1.5 to 20 cm, and the dose differences for lateral profiles within 80% field width is also within 1.5%, and the disagreements of DTA were less than 0.5 mm. The discrepancies of output factor were 2.8-5% for the three smallest cones, which were possibly caused by the effect of electron scattering at the metallic parts of the detector shielding.

Conclusion: For Monte Carlo simulations of LINAC and dose calculations it is important to accurately determine the initial electron beam. These parameters, mean energy and FWHM of incidence electron, have been determined by matching the calculated dose with the measured dose through a trial and error process.This study also applied some methods to increase simulation efficiency which could be the reference of future research.

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Dosimetric evaluation of VMAT planning for Elekta Agility using Eclipse planning system

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Purpose or Objective: VMAT planning for Elekta linear accelerators with newest MLC-Agility is supported with the following treatment planning systems: Pinnacle3 (Philips, Fitchburg WI, USA), Oncentra Masterplan (Elekta), RayStation (RaySearch Laboratories AB, Stockholm, Sweden) and Monaco (Elekta). The newest release of Eclipse TPS V13.5 (Varian Medical Systems, Palo Alto, CA, USA) includes an algorithm for Elekta Agility VMAT planning. The purpose of this study was to assess dosimetric validation of the new VMAT optimization algorithm implemented in the treatment planning system Eclipse TPS V13.5 for the latest Elekta MLC-Agility. Testing was performed by creating and dosimetrically verifying VMAT plans for different anatomical sites.